

11

## EXTERNAL VALIDITY CONSIDERATIONS OF A BIOCYBERNETIC SYSTEM FOR ADAPTIVE AUTOMATION

Mark W. Scerbo      Todd M. Eischeid  
Old Dominion University

The report discusses the results of a research project aimed at generating a software application library termed the DAQ EEG Processor (or DEP) that collects and processes raw electroencephalographic data. The purpose of this system is to reduce raw EEG data in real time into information that is useful to researchers, such as power bands and indices of engagement. DEP improves upon existing EEG processing systems in that it can be seamlessly integrated into many software development environments to provide realtime data.

DEP takes advantage of Microsoft Corporation's Component Object Model Technology (COM), which, in short, allows language independent, inter-application communication and transfer of data. According to the COM specification, COM objects can be written in different languages, run in different process spaces and on different platforms. As long as the objects adhere to the specification, they can communicate.

DEP was written using Borland Delphi 5 Enterprise Edition (see <http://www.borland.com/delphi/>), and is basically an "Automation server". Automation is an extension of the COM technology (see <http://www.microsoft.com/com/tech/com.asp>), and refers to the ability of a given application to programmatically control objects in another, separate application. An Automation server exposes its functionality for client applications, called Automation controllers, to use. A controller can be any

application created in an environment that supports Automation, such as Delphi, Visual Basic, or Microsoft Access. Thus, experimental tasks on a computer (i.e. a flight simulator task) can be written in any one of these programming languages while accessing realtime EEG data.

The data provided DEP (i.e. power band information, indices of mental engagement) is correlated with human mental workload and alertness. Thus researchers can use this system to obtain real-time physiological measures of these constructs, while participants are engaged in flight-related tasks.

Further, simultaneous measures of human performance and physiological data can now be obtained in realtime within one software application. This will facilitate the development of performance/physiological hybrid algorithms to measure human mental workload and hazardous states of awareness.

Due to the design of this system, a software application will be able to immediately alter environmental and/or task related parameters based on the realtime EEG and performance data. For example, an automated system could monitor a pilot's EEG in realtime during flight. If the pilot entered a hazardous state of awareness (perhaps defined by a physiological/performance algorithm), the automated system could react to the situation by allocating tasks to or away from the pilot.

DEP is very flexible in terms of its potential application. It can readily accommodate between 2 and 16 channels of EEG, and up to 100 custom EEG bands, for fine-grained analysis and reactivity. Also, as stated above, it can be used in numerous development environments on the Microsoft Windows operating system, such as Visual Basic, Delphi, LabVIEW, and Access. DEP

can also be run on a laptop computer, to provide a low profile, and used during real flights to collect EEG measures for many hours.

Development of this system is near completion, and validation with human participants will soon be performed. Initial testing with EEG signal simulation machines suggests that this system will be quite useful.